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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C.
1940 DUKE STREET
ALEXANDRIA, VA 22314

EXAMINER	
MARKHAM, WESLEY D	

ART UNIT	PAPER NUMBER
1762	

DATE MAILED: 04/05/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/662,522	DIP ET AL.	
	Examiner	Art Unit	
	Wesley D. Markham	1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 January 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-50,52-65 and 78* is/are pending in the application.

4a) Of the above claim(s) *14-19,39-50,53-57 and 65* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13,20-38,52,58-64 and 78* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *16 September 2003 and 09 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *11/30/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Acknowledgement is made of the amendment filed by the applicant on 1/30/2006, in which Claims 1 and 61 – 63 were amended, Claims 51 and 66 – 77 were canceled, and Claim 78 was added. Claims 1 – 50, 52 – 65, and 78 are pending in U.S. Application Serial No. 10/662,522. Please note that Claims 14 – 19, 39 – 50, 53 – 57, and 65 remain withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention / species, there being no allowable generic or linking claim.
2. This application contains Claims 14 – 19, 39 – 50, 53 – 57, and 65 drawn to an invention nonelected with traverse (see the 10/17/2005 election). A complete reply to the final rejection must include cancellation of nonelected claims or other appropriate action (37 CFR 1.144) See MPEP § 821.01.

Information Disclosure Statement

3. The IDS filed by the applicant on 11/30/2005 is acknowledged by the examiner, and the references listed thereon have been considered as indicated on the attached copy of the PTO-1449 form.

Oath/Declaration

4. The objection to the declaration set forth in paragraph 3 of the previous Office action (i.e., the non-final Office action mailed on 10/28/2005) is withdrawn in light of the applicant's submission of an ADS that includes the correct application filing date.

Drawings

5. The drawings filed on 9/16/2003 and 2/9/2004 (i.e., 2 replacement sheets depicting Figures 8 and 9) are acknowledged and approved by the examiner.

Claim Objections

6. The objection to Claims 61 and 62 set forth in paragraph 5 of the previous Office action is withdrawn in light of the applicant's amendment to clarify the typographical errors noted by the examiner.

Claim Rejections - 35 USC § 112

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 27, 28, and 52 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
9. **Claims 27, 28, and 52** all recite the limitation "the substrate" in line 2 of each of the claims. There is insufficient antecedent basis for this limitation in the claim.

Specifically, independent Claim 1 (from which Claims 27, 28, and 52 depend) was amended to require "a plurality of substrates". Therefore, it is unclear which of the plurality of substrates "the substrate" refers to in Claims 27, 28, and 52 (or if "the substrate" is intended to refer to each of the plurality of substrates), and the scope of the claims is unclear.

Claim Observations

10. Please note that the 35 U.S.C. 102 rejections based on Ono et al. (USPN 6,420,279), Lim (USPN 6,465,371), and Elers et al. (USPN 6,475,276) (see paragraphs 8 – 13 of the previous Office action) are withdrawn because none of the aforementioned references alone teaches all the limitations of amended independent Claim 1 (e.g., (a) providing a plurality of substrates on respective surfaces of a tier substrate holder and (b) heating the substrates to a predetermined temperature where film deposition rate is independent of temperature, in combination with the remainder of the process limitations).

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

12. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

13. Claims 1 – 4, 6, 11 – 13, 20 – 23, 27, 28, 31, 34 – 36, 38, 52, 63, and 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. (USPN 6,420,279) in view of either Kim et al. (US 2003/0013320 A1) or Hyun et al. (USPN 6,042,652), in further view of Bondestam et al. (US 2002//0157611 A1).

14. Specifically, Ono et al. teaches all the limitations of **Claims 1 – 4, 6, 11 – 13, 20 – 23, 27, 28, 31, 34 – 36, 38, 52, 63, and 64** as set forth in paragraphs 9, 31, and 39 of the previous Office action, except for (1) providing a plurality of substrates on respective surfaces of a tier substrate holder in the process chamber, and (2) heating the substrates to a predetermined temperature where film deposition rate is independent of temperature. Regarding (1), Ono et al. is silent regarding the specific number of substrates and the structure of the substrate holder in the ALD process chamber. However, it is clear that the process of Ono et al. can be carried out in commercial ALD tools (Col.3, lines 1 – 4). Kim et al. teaches an ALD apparatus and

process comprising providing a plurality of substrates (100 substrates or more – paragraphs [0029] and [0030]) on respective surfaces of a tier substrate holder in a process chamber of a batch-type ALD processing system (Abstract, Figure 1, paragraphs [0013] – [0016], [0026] – [0032], [0034] – [0046]). The apparatus of Kim et al. is capable of depositing a wide variety of films by ALD, including oxides such as HfO_2 and ZrO_2 (i.e., the same films deposited by Ono et al.) (paragraph [0046]). Additionally, the step of providing a plurality of substrates on respective surfaces of a tier substrate holder in the ALD process chamber taught by Kim et al. provides the following advantages: (1) enables high throughput (due to simultaneous multi substrate processing) while still providing high-quality thin films, thereby making mass production possible (paragraphs [0012] and [0062]), (2) is less costly and easier to maintain than conventional ALD apparatuses (paragraph [0062]), and (3) allows the plurality of wafers to be loaded and unloaded automatically and simultaneously (paragraphs [0011] and [0061]). Therefore, it would have been obvious to one of ordinary skill in the art to perform an ALD process such as that of Ono et al. by using the ALD processing scheme / apparatus of Kim et al. (i.e., providing a plurality of substrates on respective surfaces of a tier substrate holder in the ALD process chamber) in order to reap the benefits disclosed immediately above. Alternatively, Hyun et al. also teaches an ALD apparatus and process comprising providing a plurality of substrates "122" (5 or more – Col.5, lines 20 – 27) on respective surfaces of a tier substrate holder (i.e., the entire group of modules "140") in a process chamber "110" of a batch-type ALD processing system (Abstract,

Figures 3 and 4, Col.2, line 55 – Col.8, line 55). Please note that the plurality of substrates of Hyun et al. are held in a tier-like manner (in respective horizontal planes at vertical intervals – see paragraph [0035] of the applicant's specification) by the collective group of modules. As such, the modules "140" are reasonably considered to be a "tier substrate holder", as recited in independent Claim 1. The ALD apparatus of Hyun et al. is capable of depositing both binary and complex (ternary) films (Col.8, lines 45 – 49). Additionally, the step of providing a plurality of substrates on respective surfaces of a tier substrate holder in the ALD process chamber taught by Hyun et al. provides the following advantages: (1) uniformly deposits thin films on multiple substrates (Col.1, lines 8 – 11); (2) improves throughput (Col.2, lines 55 – 58, Col.8, lines 50 – 55); and (3) has a uniform temperature distribution, thereby insuring that the thin films are uniformly deposited (Col.5, lines 20 – 28, Col.7, lines 1 – 2). Therefore, it would have been obvious to one of ordinary skill in the art to perform an ALD process such as that of Ono et al. by using the ALD processing scheme / apparatus of Hyun et al. (i.e., providing a plurality of substrates on respective surfaces of a tier substrate holder in the ALD process chamber) in order to reap the benefits disclosed immediately above. Additionally, Bondestam et al. teaches that the temperature profile of an ALD process should be optimized so that a substrate temperature is within the ALD window (i.e., a temperature range at which deposition rate is independent of temperature – see figures), thereby insuring that only ALD (not decomposition, condensation, etc.) takes place on the substrate (see entire document). As such, it

would have been obvious to one of ordinary skill in the art to uniformly heat the substrates to a temperature within the ALD temperature window (i.e., a temperature at which deposition rate is independent of temperature) in the process of the combination of Ono and either Kim or Hyun, thereby insuring that no undesired deposition takes place on the substrate surface (i.e., only self-limited ALD takes place), thereby producing as high a quality film as possible. The exact temperature at which the substrates are heated (i.e., the ALD temperature window) would, of course, depend on the specific reactants being used and film being deposited (paragraph [0020] and Examples 1 – 7 of Bondestam et al.).

15. Claims 5, 7, 25, 26, and 30 – 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Chang et al. (US 2003/0031793) and Kaloyeros et al. (USPN 6,346,477).

16. The combination of Ono, Kim or Hyun, and Bondestam teaches all the limitations of **Claims 5, 7, 25, 26, and 30 – 33** as set forth above in paragraph 14, except for the claimed gas flow rate(s), pulse duration(s), and chamber pressure(s). However, Chang et al. (paragraph [0041]) and Kaloyeros et al. (Cols.8 – 9) teach that process parameters such as gas flow rate, pulse duration, temperature, and chamber pressure are result / effective variables that are interrelated and influenced by the nature of the reactants used in the ALD process. As such, it would have been obvious to one of ordinary skill in the art to have optimized the aforementioned

process conditions as result / effective variables though routine experimentation based on the specific ALD process being carried out (e.g., the ALD reactor used, the reactants used, etc.).

17. Claims 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Raaijmakers et al. (US 2001/0054769).

18. The combination of Ono, Kim or Hyun, and Bondestam teaches all the limitations of **Claims 8 and 10** as set forth above in paragraph 14, except for using a carrier gas with the metal containing precursor gas and the reactant gas. However, Raaijmakers et al. teaches using a carrier gas along with the precursor and reactant gas(es) in an ALD process (paragraphs [0079] – [0103]), and it would have been obvious to one of ordinary skill in the art to use such a carrier gas in the process of Ono in order to aid in the transportation of the precursor and reactant gases into the chamber (i.e., to provide the benefit of a stable and uniform gas flow rate).

19. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Raaijmakers et al., and in further view of Chang et al. (US 2003/0031793) and Kaloyeros et al. (USPN 6,346,477).

20. The combination of Ono, either Kim or Hyun, Bondestam, and Raaijmakers teaches all the limitations of **Claim 9** as set forth above in paragraph 18, except for the

claimed gas flow rate. However, optimizing various gas flow rates in an ALD process such as that of Ono would have been obvious to one of ordinary skill in the art in view of the teachings of Chang et al. and Kaloyeros et al. (see paragraph 16 above).

21. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Suntola et al. (USPN 6,572,705).

22. The combination of Ono et al., either Kim or Hyun, and Bondestam teaches all the limitations of **Claim 24** as set forth above in paragraph 14, except for providing a substrate with a diameter greater than about 195 mm. However, Suntola et al. teaches that ALD successfully deposits films on large substrates (e.g., 300 mm in diameter) (Col.11, line 20), and it would have been obvious to one of ordinary skill in the art to do so in order to deposit ALD films on as large a substrate as possible, thereby improving process throughput.

23. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Paranjpe (US 2003/0134038).

24. The combination of Ono et al., either Kim or Hyun, and Bondestam teaches all the limitations of **Claim 29** as set forth above in paragraph 14, except for forming the metal-containing precursor by flowing a metal-containing precursor liquid into a vaporizer at a flow rate between about 0.05 ccm and 1 ccm. Specifically, Ono et al.

is silent regarding how the metal containing precursors (e.g., Zr or Hf nitrates) are converted to a vapor / gaseous phase suitable for ALD. Paranjpe teaches delivering a metal containing precursor pulse by flowing a precursor liquid into a vaporizer (paragraph [0068]). The system taught by Paranjpe has the following advantages: delivering a high maximum flow rate to the reactor, reducing waste, and minimizing particle generation. Therefore, it would have been obvious to one of ordinary skill in the art to deliver the precursors of Ono in the manner taught by Paranjpe (i.e., to a vaporizer and then to the chamber) in order to reap the advantages discussed above. The liquid flow rate to the vaporizer would, of course, depend on the desired precursor vapor flow rate into the ALD chamber.

25. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Jeon (USPN 6,607,973).

26. The combination of Ono, either Kim or Hyun, and Bondestam teaches all the limitations of **Claim 37** as set forth above in paragraph 14, except for the claimed annealing temperature of between about 150° C and about 1000° C. Specifically, Ono et al. teaches annealing the film to condition the film and any interfaces between the layers (Col.5, lines 8 – 10) but is silent regarding the annealing temperature. Jeon teaches annealing a high-k dielectric layer (e.g., HfO_2, which is a material taught by Ono) at the claimed temperature (abstract, Col.4, lines 56 – 59), and it would have been obvious to one of ordinary skill in the art to do so in order to

condition the film and any interfaces between the layers, as desired by Ono, at a suitable annealing temperature.

27. Claims 58 – 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Leskela et al. (US 2002/0182320).

28. The combination of Ono, either Kim or Hyun, and Bondestam teaches all the limitations of **Claims 58 – 60** as set forth above in paragraph 14, except for the claimed Hf or Zr alkylamide precursors. However, Leskela et al. teaches that the claimed alkylamide precursors are effective for producing metal containing (e.g., zirconium and hafnium) films by ALD, and it would have been obvious to one of ordinary skill in the art to use such precursors as opposed to the nitrate precursors taught by Ono with the reasonable expectation of success and obtaining similar results (i.e., successfully depositing the Zr- or Hf-containing film by ALD, regardless of whether a nitrate or an alkylamide is used as the precursor).

29. Claims 61 and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., in further view of Cook et al. (US 2003/0049372).

30. The combination of Ono, either Kim or Hyun, and Bondestam teaches all the limitations of **Claims 61 and 62** as set forth above in paragraph 14, except for providing a plurality of substrates in the process chamber and the claimed WIW

uniformity (e.g., about 10% to about 15%). However, Cook et al. teaches that optimizing an ALD process results in excellent WIW uniformity (see entire document), and it would have been obvious to one of ordinary skill in the art to optimize the batch ALD process of the combination of Ono, either Kim or Hyun, and Bondestam in order to maximize the WIW uniformity (as taught by Cook et al.), thereby insuring a high quality product.

31. Claim 78 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ono et al. in view of either Kim et al. or Hyun et al., in further view of Bondestam et al., and in further view of Pang et al. (USPN 6,946,336), Gadgil et al. (US 2004/0211357 A1), or Putkonen (USPN 6,548,424).

32. The combination of Ono, Kim or Hyun, and Bondestam teaches all the limitations of **Claim 78** as set forth above in paragraph 14, except for a method wherein the deposition rate is about 1 A per cycle. However, Pang et al. teaches that a preferred ALD technique for depositing metal oxide dielectric films includes a deposition rate as low as 1 A per cycle, allowing for a high degree of precision in layer growth (Col.8, lines 8 – 37). Therefore, it would have been obvious to one of ordinary skill in the art to deposit ALD films at such a rate because the low rate of 1 A per cycle provides a high degree of precision in layer growth. Alternatively, Gadgil et al. teaches that, in ALD, the rate of deposition is fixed and solely dependent on the speed of completion of a single ALD sequence, which is typically between 1 A to 3 A per cycle, depending on the dimensions of the monolayer (paragraph [0024]). In

other words, Gadgil et al. teaches that the deposition rate per cycle is a result / effective variable that is correlated to the dimensions of the specific monolayer being deposited. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the deposition rate per cycle depending on the thickness of the specific monolayer being deposited (thicker monolayer = more A per cycle), which of course is determined by the chemical composition of the film being deposited. Alternatively, Putkonen teaches that the purging time in an ALD process is optimized to optimize the growth rate per cycle (Col.4, lines 55 – 58), and as such, it would have been obvious to one of ordinary skill in the art to optimize the purging gas time in the ALD process of Ono, thereby correspondingly optimizing the growth rate per cycle of the ALD process.

Response to Arguments

33. Applicant's arguments filed on 1/30/2006 have been fully considered but they are not persuasive. Specifically, the arguments are moot in view of the new grounds of rejection set forth above.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D. Markham whose telephone number is (571) 272-1422. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tim Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Wesley D Markham
Examiner
Art Unit 1762

WDM

TIMOTHY MEEKS
SUPERVISORY PATENT EXAMINER